

# Claims

[c1] What is claimed is:

1.A printing apparatus comprising:

a printhead for ejecting ink from a plurality of nozzles,  
the printhead comprising:

a substrate; and

a plurality of heaters arranged on the substrate for heat-  
ing ink in the printhead to generate bubbles in the ink

and eject the ink through the corresponding nozzles;

a signal generator for generating printing pulses and

non-printing pulses used to control the heaters, the

printing pulses controlling the heaters to generate suffi-

cient heat energy to eject ink from the nozzles for print-

ing data, and the non-printing pulses controlling the

heaters to generate heat energy that is not sufficient to

eject ink from the nozzles for raising a temperature of  
the ink;

a print data comparator for comparing a percentage of  
data printed during a predetermined period of time with  
a threshold value; and

a control circuit for varying the non-printing pulses gen-  
erated by the signal generator according to the percent-  
age of data printed during the predetermined period of

time and the threshold value.

- [c2] 2.The printing apparatus of claim 1 wherein if the percentage of data printed during the predetermined period of time is above the threshold value, a width of the non-printing pulses generated by the signal generator is lowered, and if the percentage of data is below the threshold value, the width of the non-printing pulses generated by the signal generator is raised.
- [c3] 3.The printing apparatus of claim 1 wherein the control circuit varies a frequency of the non-printing pulses generated by the signal generator according to the percentage of data printed during the predetermined period of time, wherein if the percentage of data is above the threshold value, the frequency of the non-printing pulses generated by the signal generator is lowered, and if the percentage of data is below the threshold value, the frequency of the non-printing pulses generated by the signal generator is raised.
- [c4] 4.The printing apparatus of claim 1 wherein the control circuit varies a number of the non-printing pulses generated by the signal generator according to the percentage of data printed during the predetermined period of time, wherein if the percentage of data is above the threshold value, the number of the non-printing pulses

generated by the signal generator is lowered, and if the percentage of data is below the threshold value, the number of the non-printing pulses generated by the signal generator is raised.

[c5] 5.The printing apparatus of claim 1 wherein the control circuit varies a voltage of the non-printing pulses generated by the signal generator according to the percentage of data printed during the predetermined period of time, wherein if the percentage of data is above the threshold value, the voltage of the non-printing pulses generated by the signal generator is lowered, and if the percentage of data is below the threshold value, the voltage of the non-printing pulses generated by the signal generator is raised.

[c6] 6.The printing apparatus of claim 1 wherein the print-head further comprises a temperature sensor for measuring a temperature of the substrate and a temperature comparator for comparing the temperature of the substrate with a reference temperature.

[c7] 7.The printing apparatus of claim 6 wherein the control circuit varies a frequency of the non-printing pulses generated by the signal generator according to a temperature difference between the temperature of the substrate and the reference temperature, wherein if the

temperature of the substrate is above the reference temperature, the frequency of the non-printing pulses generated by the signal generator is lowered, and if the temperature of the substrate is below the reference temperature, the frequency of the non-printing pulses generated by the signal generator is raised.

[c8] 8.The printing apparatus of claim 6 wherein the control circuit varies a width of the non-printing pulses generated by the signal generator according to a temperature difference between the temperature of the substrate and the reference temperature, wherein if the temperature of the substrate is above the reference temperature, the width of the non-printing pulses generated by the signal generator is lowered, and if the temperature of the substrate is below the reference temperature, the width of the non-printing pulses generated by the signal generator is raised.

[c9] 9.The printing apparatus of claim 6 wherein the control circuit varies a number of the non-printing pulses generated by the signal generator according to a temperature difference between the temperature of the substrate and the reference temperature, wherein if the temperature of the substrate is above the reference temperature, the number of the non-printing pulses generated by the signal generator is lowered, and if the temperature of the

substrate is below the reference temperature, the number of the non-printing pulses generated by the signal generator is raised.

[c10] 10. The printing apparatus of claim 6 wherein the control circuit varies a voltage of the non-printing pulses generated by the signal generator according to a temperature difference between the temperature of the substrate and the reference temperature, wherein if the temperature of the substrate is above the reference temperature, the voltage of the non-printing pulses generated by the signal generator is lowered, and if the temperature of the substrate is below the reference temperature, the voltage of the non-printing pulses generated by the signal generator is raised.

[c11] 11. A printing apparatus comprising:  
a printhead for ejecting ink from a plurality of nozzles, the printhead comprising:  
a substrate; and  
a plurality of heaters arranged on the substrate for heating ink in the printhead to generate bubbles in the ink and eject the ink through the corresponding nozzles;  
a signal generator for generating printing pulses and non-printing pulses used to control the heaters, the printing pulses controlling the heaters to generate sufficient heat energy to eject ink from the nozzles for print-

ing data, and the non-printing pulses controlling the heaters to generate heat energy that is not sufficient to eject ink from the nozzles for raising a temperature of the ink;

a temperature sensor for measuring a temperature of the substrate;

a temperature comparator for comparing the temperature of the substrate with a reference temperature; and

a control circuit for varying the non-printing pulses generated by the signal generator according to a temperature difference between the temperature of the substrate and the reference temperature.

[c12] 12.The printing apparatus of claim 11 wherein if the temperature of the substrate is above the reference temperature, a voltage of the non-printing pulses generated by the signal generator is lowered, and if the temperature of the substrate is below the reference temperature, the voltage of the non-printing pulses generated by the signal generator is raised.

[c13] 13.The printing apparatus of claim 11 wherein the control circuit varies a width of the non-printing pulses generated by the signal generator according to a temperature difference between the temperature of the substrate and the reference temperature, wherein if the temperature of the substrate is above the reference tem-

perature, the width of the non-printing pulses generated by the signal generator is lowered, and if the temperature of the substrate is below the reference temperature, the width of the non-printing pulses generated by the signal generator is raised.

[c14] 14. The printing apparatus of claim 11 wherein the control circuit varies a number of the non-printing pulses generated by the signal generator according to a temperature difference between the temperature of the substrate and the reference temperature, wherein if the temperature of the substrate is above the reference temperature, the number of the non-printing pulses generated by the signal generator is lowered, and if the temperature of the substrate is below the reference temperature, the number of the non-printing pulses generated by the signal generator is raised.

[c15] 15. The printing apparatus of claim 11 wherein the control circuit varies a frequency of the non-printing pulses generated by the signal generator according to a temperature difference between the temperature of the substrate and the reference temperature, wherein if the temperature of the substrate is above the reference temperature, the frequency of the non-printing pulses generated by the signal generator is lowered, and if the temperature of the substrate is below the reference tem-

perature, the frequency of the non-printing pulses generated by the signal generator is raised.

[c16] 16.A method for heating a printhead in a printing apparatus, the method comprising the steps of:  
providing a printing apparatus, including:  
a printhead for ejecting ink from a plurality of nozzles, the printhead comprising:  
a substrate; and  
a plurality of heaters arranged on the substrate for heating ink in the printhead to generate bubbles in the ink and eject the ink through the corresponding nozzles;  
generating printing pulses and non-printing pulses used to control the heaters, the printing pulses controlling the heaters to generate sufficient heat energy to eject ink from the nozzles for printing data, and the non-printing pulses controlling the heaters to generate heat energy that is not sufficient to eject ink from the nozzles for raising a temperature of the ink;  
comparing a percentage of data printed during a predetermined period of time with a threshold value; and  
varying the non-printing pulses according to the percentage of data printed during the predetermined period of time and the threshold value.

[c17] 17.The method of claim 16 further comprising lowering a width of the non-printing pulses if the percentage of



data printed during the predetermined period of time is above the threshold value, and raising the width of the non-printing pulses if the percentage of data printed during the predetermined period of time is below the threshold value.

[c18] 18.The method of claim 16 further comprising lowering a frequency of the non-printing pulses if the percentage of data printed during the predetermined period of time is above the threshold value, and raising the frequency of the non-printing pulses if the percentage of data printed during the predetermined period of time is below the threshold value.

[c19] 19.The method of claim 16 further comprising lowering a number of the non-printing pulses if the percentage of data printed during the predetermined period of time is above the threshold value, and raising the number of the non-printing pulses if the percentage of data printed during the predetermined period of time is below the threshold value.

[c20] 20.The method of claim 16 further comprising lowering a voltage of the non-printing pulses if the percentage of data printed during the predetermined period of time is above the threshold value, and raising the voltage of the non-printing pulses if the percentage of data printed

during the predetermined period of time is below the threshold value.

[c21] 21.A method for heating a printhead in a printing apparatus, the method comprising the steps of:  
providing a printing apparatus, including:  
a printhead for ejecting ink from a plurality of nozzles,  
the printhead comprising:  
a substrate; and  
a plurality of heaters arranged on the substrate for heating ink in the printhead to generate bubbles in the ink and eject the ink through the corresponding nozzles;  
generating printing pulses and non-printing pulses used to control the heaters, the printing pulses controlling the heaters to generate sufficient heat energy to eject ink from the nozzles for printing data, and the non-printing pulses controlling the heaters to generate heat energy that is not sufficient to eject ink from the nozzles for raising a temperature of the ink;  
measuring a temperature of the substrate;  
comparing the temperature of the substrate with a reference temperature; and  
varying the non-printing pulses according to a temperature difference between the temperature of the substrate and the reference temperature.

- [c22] 22.The method of claim 21 further comprising lowering avoltage of the non-printing pulses if the temperature of the substrate is above the reference temperature, and raising the voltage of the non-printing pulses if the temperature of the substrate is below the reference temperature.
- [c23] 23.The method of claim 21 further comprising lowering a width of the non-printing pulsesif the temperature of the substrate is above the reference temperature, and raising the width of the non-printing pulsesif the temperature of the substrate is below the reference temperature.
- [c24] 24.The method of claim 21 further comprising lowering a number of the non-printing pulsesif the temperature of the substrate is above the reference temperature, and raising the number of the non-printing pulsesif the temperature of the substrate is below the reference temperature.
- [c25] 25.The method of claim 21 further comprising lowering a frequency of the non-printing pulsesif the temperature of the substrate is above the reference temperature, and raising the frequency of the non-printing pulsesif the temperature of the substrate is below the reference temperature.

